Center Independent Research & Development: GSFC IRAD

Optimetric Measurements with Continuous Optical Carriers Phase of Coherent Optical Communication

Completed Technology Project (2016 - 2017)

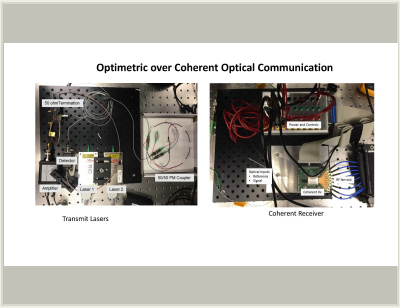
Project Introduction

We propose to perform a study and experimental demonstration of ultra-high precision optimetric measurements (50 nm range error, 50 nm/s ranging rate error) with continuous optical carrier phase measurement on a coherent optical communication system. This approach improves optimetric measurement sensitivity by orders of magnitude vs. the current RF or RF over optical based optimetrics (10 μm range error, 10 μm/s ranging rate error). It will be game changing technology with such high precision ranging and high bandwidth communication. It will service both science and NAV/COMM at a new level of ranging precision and comm capacity. It will also advances the state-of-the-art for the optical comm system with high bandwidth and high precision ranging. It will be an enabler for precision formation flying missions that include: virtual sensors, sensor webs, large-number-multi-spacecraft distributed missions, autonomous rendezvous & docking; and enabler for gravitational based small-sat scientific missions.

Continuous optical phase measurement improves ranging accuracy by orders of magnitude due to the nature of much higher optical carrier frequency (4 to 5 orders of magnitude higher than RF). To demonstrate this phase measurement over optical communication links, our study will leverage the vast technology progress in the fields: **1.** High speed coherent optical communication (Telecomm) (>100 Gbit/s) with photonic integrated circuit (PIC) and high speed analog and digital electronics. **2.** Low noise laser source for gravity wave measurement (LISA) enables continuous optical phase measurement over long distance (>1 million km). This study will leverage the state of art hardware from both fields to demonstrate close LISA grade phase measurement accuracy and greater than 100GBPS data communication capability. Furthermore, we propose two more experiments to be implemented on the platform by taking advantages of wavelength division multiplexing (WDM). **1.** WDM combines a second channel with low noise CW laser. It further improves the phase measurement accuracy by avoiding high data rate (>25 GHz) phase modulation introduced noise. **2.** WDM combines two more CW optical channels, then performs a cross correlation among these two channel. This operation enhances the common mode signals (the relative distance of the two satellites) and suppresses uncorrelated noises (electronics, laser, and digital noised). It will lower the instrument noise floor, reduce the hardware complexity, and hence further reduce the SWaP. This proposal also leverages last year's CIF/IRAD project "High Precision RF Ranging and Range Rate Measurements over Optical Carrier and Laser Communication in Cubesat Platform" on both technologies and methodologies. The success of this study will provide platform with both ranging over continuous optical phase (~50 nm error) and high rate coherent optical communication.

Anticipated Benefits

High precision formation flying for earth and planetary science, heliophysics,



Optimetric over Coherent Optical Communication

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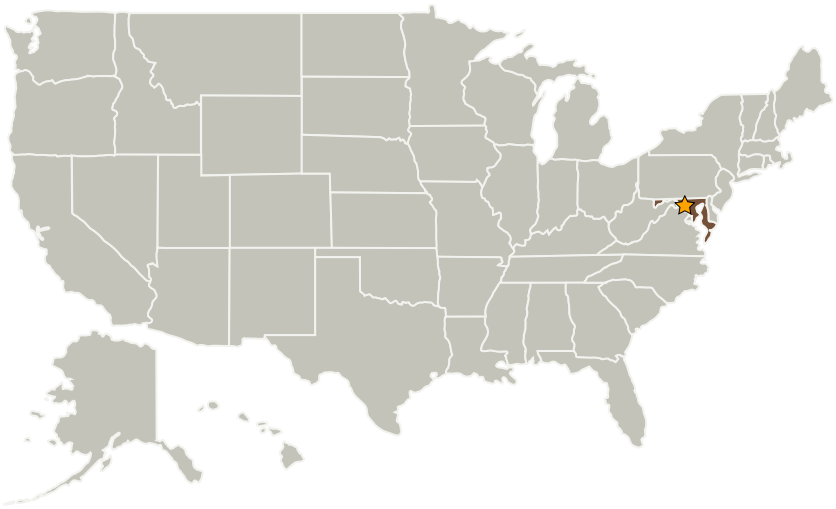
and astrophysics

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Project Transitions

October 2016: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Managers:

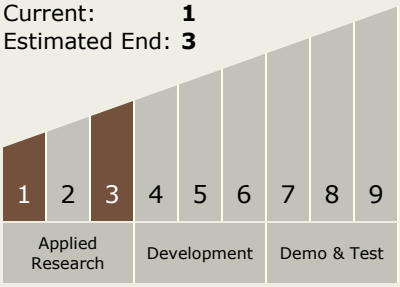
Terence A Doiron
Timothy D Beach

Principal Investigator:

Guangning Yang

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **3**



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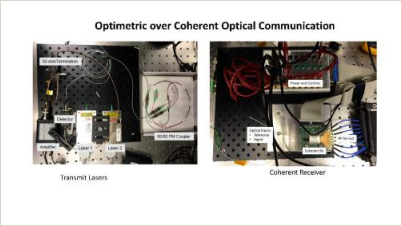
September 2017: Closed out

Closeout Summary: The purpose of the Goddard Space Flight Center's Internal Research and Development (IRAD) program is to support new technology development and to address scientific challenges. Each year, Principal Investigators (PIs) submit IRAD proposals and compete for funding for their development projects. Goddard's IRAD program supports eight Lines of Business: Astrophysics; Communications and Navigation; Cross-Cutting Technology and Capabilities; Earth Science; Heliophysics; Planetary Science; Science Small Satellites Technology; and Suborbital Platforms and Range Services.Task progress is evaluated twice a year at the Mid-term IRAD review and the end of the year. When the funding period has ended, the PIs compete again for IRAD funding or seek new sources of development and research funding or agree to external partnerships and collaborations. In some cases, when the development work has reached the appropriate Technology Readiness Level (TRL) level, the product is integrated into an actual NASA mission or used to support other government agencies. The technology may also be licensed out to the industry.The completion of a project does not necessarily indicate that the development work has stopped. The work could potentially continue in the future as a follow-on IRAD; or used in collaboration or partnership with Academia, Industry and other Government Agencies.If you are interested in partnering with NASA, see the TechPort Partnerships documentation available on the TechPort Help tab. http://techport.nasa.gov/help

Images



Optimetric over Coherent Optical Communication
Optimetric over Coherent Optical Communication
(https://techport.nasa.gov/image/26411)

Project Website:

http://aetd.gsfc.nasa.gov/

Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.1 Optical Communications
    - TX05.1.6 Optimetrics

Target Destination

Earth